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Signed Andrew Gersey

Dated 11 October 1999

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# Request for grant of a patent

*(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)*

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

98P078

2. Patent application number
*(The Patent Office will fill in this part)* 16 SEP 1998

**9820089.2**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

PROTOL POWDER COATINGS LIMITED
Vitesse Avenue
Triumph Trading Park,
Speke Hall Road,
LIVERPOOL
L24 9GQ
United Kingdom

Patents ADP number *(if you know it)*

7513344001

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

4. Title of the invention

A RECYCLING PROCESS

5. Name of your agent *(if you have one)*

POTTS, KERR & CO.

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

15, Hamilton Square,
Birkenhead,
Merseyside,
L41 6BR,
United Kingdom.

Patents ADP number *(if you know it)*

1313002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / year)* |
|---|---|---|

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

| Number of earlier application | Date of filing *(day / month / year)* |
|---|---|

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

*a) any applicant named in part 3 is not an inventor, or*
*b) there is an inventor who is not named as an applicant, or*
*c) any named applicant is a corporate body.*
*See note (d))*

YES

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

| | |
|---|---|
| Continuation sheets of this form | |
| Description | 6 |
| Claim(s) | |
| Abstract | |
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10. If you are also filing any of the following, state how many against each item.

| | |
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| Priority documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent *(Patents Form 7/77)* | |
| Request for preliminary examination and search *(Patents Form 9/77)* | |
| Request for substantive examination *(Patents Form 10/77)* | |
| Any other documents *(please specify)* | |

11. I/We request the grant of a patent on the basis of this application.

Signature: Potts, Kerr & Co. Date: 15 September 1998

12. Name and daytime telephone number of person to contact in the United Kingdom: P.A. Thomson 0151 647 6746

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# A Recycling Process

The present invention relates to a recycling process. In particular, the present invention relates to a recycling process that reclaims the fines produced during the manufacture of powder coatings, such that the fines can be reused in powder coatings.

As an alternative to using traditional liquid paints, powder coatings are sprayed onto everyday items, for example, fridges, ovens, filing cabinets etc.

Powder coatings adhere to the metal substrate of the item that is sprayed, by electrostatic attraction. The painted or coated item is then heated in an oven, or cured by, for example, infrared radiation. This produces the appropriate chemical reaction that provides the metal substrate with its finished surface.

Additionally, and by the use of NIR technology (Near InfraRed), substrates such as wood or plastic can also be painted or coated using powder coating technology.

Regardless of the method of curing or heating utilised, in order to ensure an optimal adhesion of the powder coating to the substrate of the item being coated, a homogeneous temperature through the whole powder, substrate and boundary layer is required.

Generally, such powder coatings are manufactured by mixing the raw materials together, for example, resins, curing agents, fillers, pigments etc, and then extruding same into a continuous sheet by the application of heat and pressure. On cooling the resultant sheet, same is broken up into rough chips, which are then milled to produce a powder coating with a very specific particle size. The milling process is air fed to convey the product, as well as to take away the particles that are too small to meet the particular size specification. These small particles, which are commonly referred to in the industry as "fines", and are referred to throughout this application as "fines", are then collected on filters prior to being discharged into containers.

Although it is known to melt the fines into blocks and use the resulting blocks as an insulating material in building construction, as well as to use the fines as a filler or extender in battery casings, presently, the bulk of these collected fines are disposed of via landfill, which is not only costly, but is a waste of valuable raw materials and is environmentally unsound.

The reasons why such fines are mostly disposed of are that there are many problems associated with handling such fines. In particular:

1) Due to the extremely low bulk density of the fines, they occupy a large volume for storage, that is, given their very little mass;

2) Due to the physical nature of such fines, they are very difficult to handle and behave more like a liquid than a powder. Consequently, and due to their physical nature, they are not compatible with traditional powder handling techniques, or equipment for batch metering, blending or extrusion; and

3.) Powder coating fines are by definition a "dust" and as a result thereof, they can easily be collected and contained as parts of a milling extraction plant. However, any attempt to re-utilise the collected fines as a raw material utilising standard equipment and technology, will energise the particles in such way as to have them extracted once again into the process dust collection system, or flow out, of any containing hoppers, thus defying any standard network operations.

Therefore, there is a need to provide a recycling process that converts the fines from a dust to a grain that is easier to handle. In particular, there is the need to provide a recycling process which can move the powder coatings industry towards a zero waste option.

In an attempt to devise such a process, we attempted a number of processes.

One of such processes involved processing the fines through a high pressure roll compactor. The roll pressure was varied from 5 to 100 bar and the screw feed was varied from minimum to maximum. It was observed that no compaction of the fines occurred and as a result thereof, it was concluded that such a method was not viable.

In a further attempt to provide a suitable process, the fines were placed in a high shear mixing vessel and heated via a steam jacket. The mixing blades and side refiner speeds were varied, together with the temperature. This resulted in the fines fusing into a solid block that almost destroyed the mixing vessel drive mechanism. In an attempt to overcome the observed problem, namely, the fines fusing into a solid block, several other attempts were made to cool down the mass, once the initial fusion temperature had been reached; however, all attempts in this regard failed, and no useful granulated material was produced. Once again, it was concluded that such a process was not viable.

With a view to trying to establish a more accurate profile of the fusion process, several experiments were undertaken in a laboratory oven. These involved placing 300g of fines onto a tray and then subjecting the fines to different temperatures, for different durations of time. Such an approach was adopted with a view to narrowing down the range at which the fines would start to fuse. On doing so, it was observed that if the temperature and duration parameters were too low, no meaningful product could be produced, and if too high, the fines fused into solid block and hence, were unusable.

With reference to Table 1 below, the results of such experiments can be seen:

| Duration | Temperature | % Product[1] |
|---|---|---|
| 1 hour | 70°C | 58% |
| 2 hours | 70°C | 83% |

[1] The % Product column indicates final yield of granular material once the semi-fused mass was crushed and screened through a 3.0 mm screen and then sieved on a 212 micron screen to remove any fines.

It was observed that the resulting grains were easy to handle and could be readily used as either a finished, non-colour specific, powder coating, that is, once the grains had been crushed to the correct particle size, or as a raw material for use in producing a new, colour specific, powder coating. With reference to the latter use, the resulting grains are preferably added at an addition level of around 5% to the new, colour specific, powder coating.

In light of our findings it is believed that in order to make the fines reusable and more manageable, it is essential to heat the fines to a point where they become tacky or semi-fused i.e. up to a point where the fines are not fully melted or cross-linked. If over-heated, the coating is fully cured and cannot be reused as a powder coating.

According to the present invention there is provided a process for recycling fines produced during the production of powder coatings comprising the steps of:

heating the fines for a sufficient time and at a sufficient temperature such that a reasonable product is obtained;

cooling such product;

crushing the cooled product to produce particles of a desired particle size; and

removing any particles which are not of the desired particle size.

It is an object of the present invention to provide a recycling process that enables the fines produced during the production of powder coatings to be reused as a powder coating.

In a preferred embodiment, the fines are heated for a duration of 30 minutes to 4 hours, preferably 2 hours.

Further preferably, the fines are heated at a temperature of 60-80°C, preferably 70°C.

Further preferably, after crushing, the resulting particles have a size of 3mm to 212 microns.

Further preferably, any particles having a size of less than 212 microns are removed from the resultant product.

One, non-limiting, example of a recycling process of the present invention will now be described with reference to a production trial carried out by us and described hereinbelow:

**Production trial:**

Several tons of fines were processed in a steam heated tray oven. The trays were lined with Melinex (RTM), which is a high melting point plastic film that will prevent adhesion or coating of the trays.

After a period of two hours, at a temperature of 70° C, it was observed that the mass on the trays had transformed into a crude honeycomb of product. This product was removed from the oven and allowed to cool on the trays.

The cooled mass was then removed from the trays and placed in a feed hopper to a crushing and screening plant. The particle size of the resulting grains produced was in the range of 3.00 mm to 212 microns.

The resulting grains were then reprocessed as a new raw material component in some test formulations at an inclusion rate of around 5%. The resulting test powder coatings were sprayed and baked in the normal QC process and found to be satisfactory.

Although the recycling process of the present invention has been described by way of example to the fines being processed in a steam heated tray oven, it is to be understood that the process could also be carried out in a continuous tunnel drier; a continuous or batch fluid drier, in a heated continuously fed screw feed drier, or in any other suitable heating or curing apparatus.